

EFFECT OF WESTERN WHITE PINE CONE PRODUCTION VARIABILITY ON MOUNTAIN PINE CONE BEETLE POPULATION LEVELS

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ABSTRACT.— Yearly variation in numbers of cones produced by western white pine was found to affect the population level of the mountain pine cone beetle. In years when cone production is moderate to heavy, beetle populations increase. Increasing beetle populations are ultimately limited by poor cone crops, which increase competition for nutrients and oviposition sites. Variability in western white pine cone production is regarded as the most important factor regulating populations of the mountain pine cone beetle.

Cone production in western white pine (*Pinus monticola* Douglas), and other conifers is typically periodic, with varying numbers of years between heavy crops (Rehfeldt et al. 1971, Franklin et al. 1974, Eis 1976). In the study by Rehfeldt et al. (1971) western white pine cone production was found to follow cycles of approximately four years. Franklin et al. (1974) found western white pine to be the most consistent cone producer of several conifers studied. They found total cone crop failure to be rare in western white pine. Puritch (1972) regarded tree metabolism, climate, and biotic agents as important factors affecting cone production.

The variability in pine cone production is extremely important in regulation of cone beetle population densities. The relationship between pine cone production and cone beetle population levels has been previously reported for eastern white pine (Henson 1964, Morgan and Mailu 1976), red pine (Mattson 1971, 1978, 1980), and pinyon pine (Forcella 1980). This study reports a similar relationship between western white pine and the mountain pine cone beetle (*Conophthorus ponderosae* Hopkins = *Conophthorus monticolae* Hopkins, Coleoptera: Scolytidae).

This study was conducted during the period 1977 through 1981 at the Sandpoint Seed Orchard, Sandpoint, Idaho. The seed orchard was established in 1960 using grafts from white pine blister-rust-resistant parent trees. It has provided an interim seed source of blister-rust-resistant planting stock for reforestation (Bingham et al. 1963). Cone production

began in the early 1960s and slowly increased from year to year. Increased cone production allowed a buildup in the mountain pine cone beetle population, and by 1970 a large beetle population existed in the orchard.

MATERIALS AND METHODS

Beginning in 1977, and each year thereafter, counts were made of the number of cones produced and the number attacked by beetles on each tree in the orchard. The data for 1977 were provided by the USDA Forest Service, Intermountain Forest and Range Ex-

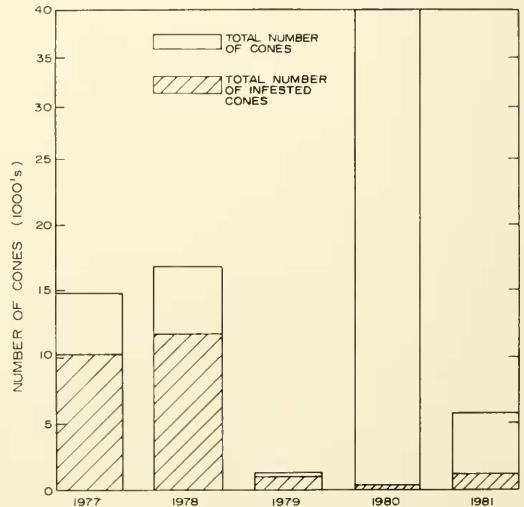


Fig. 1. The relationship between cone production in western white pine and attacks by the mountain pine cone beetle in the Sandpoint Seed Orchard, Idaho, 1977-81.

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TABLE 1. Number of trees counted, total and mean cone production, total and mean cone beetle attacks, and percent of cones attacked are shown for each of the study years.

Year	Number of trees	Cones produced		Cones attacked		Percent cones attacked
		Total	Mean	Total	Mean	
1977	591	12,651	21.41	10,136	17.15	80.12
1978	583	16,739	28.71	11,574	19.84	69.14
1979	580	830	1.43	747	1.29	90.00
1980	519	39,306	75.73	130	0.25	0.33
1981	236	5,717	24.22	305	1.29	5.33
Total		75,240	29.99	22,892	9.12	30.43

periment Station, Moscow, Idaho. Counts were made by way of binoculars, tree climbing, and a hydraulic lift truck.

RESULTS

Results of this study are shown in Table 1 and are represented graphically in Figure 1.

Moderate cone crops were produced in 1977 and in 1978, maintaining the high cone beetle population that had developed in preceding years. In 1979 cone production was very low and severe cold temperatures in the winter of 1978-79 further reduced the cone crop. Cone beetle utilization of the remaining cones was nearly 100%. A large reduction in the cone beetle population occurred due to lack of available cones for oviposition and feeding. In 1980 a bumper crop was produced, but the low cone beetle population was unable to exploit the cones to any great extent. In 1981 cone production was again low, but higher than in 1979, and the beetle population increased.

DISCUSSION

Fluctuation in current year cone numbers appears to be the most important factor regulating cone beetle population size. Previous reports on red pine (Mattson 1971, 1978, 1980), ponderosa pine (Dale and Schenk 1978), and pinyon pine (Forcella 1980) described similar relationships. Beetles can survive by initial feeding in year-old cones, but the quality of such food is reduced (Morgan and Mailu 1976). In addition, old cones cannot be utilized for oviposition.

More important than food quality is food quantity, i.e., the number of cones available in a given area. Beetle populations increased when successive moderate or heavy cone

crops occurred, as in 1977 and 1978. The population was ultimately limited when cone availability was drastically decreased in 1979. In 1981 the cone beetle population had adequate cones for feeding and the beetle population was again increasing.

The intermittent production of seed by various conifers may be an adaptive mechanism decreasing losses by seed and cone insects (Henson 1964). Mattson (1978) suggested that seed and cone insects, by attacking cones during heavy crop years, remove the depressing effect of a large crop on subsequent crops, thereby enhancing future abundance of host material by reducing it at present. Feeding by seed and cone insects may be partly responsible for the periodic nature of cone production.

Cone production cycles and beetle attacks are erratic, but large crops typically suffer lower percentage losses to seed and cone insects (Schenk and Goyer 1967). Damage is greatest when small crops follow large ones, because cone beetle numbers build up when food is abundant. During years when small crops are produced, competition for food and oviposition sites causes high mortality and few new beetles are produced.

LITERATURE CITED

- BINGHAM, R. T., J. W. HANOVER, H. J. HARTMAN, AND Q. W. LARSON. 1963. Western white pine experimental seed orchard established. *J. Forest.* 61:300-301.
- DALE, J. W., AND J. A. SCHENK. 1978. Cone production and insect-caused seed losses of ponderosa pine in Idaho and adjacent Washington and Montana. *Bull. Forest, Wildlife, Range Exp. Sta. 24. Univ. of Idaho, Moscow.* 15 pp.
- EIS, S. 1976. Association of western white pine cone crops with weather variables. *Canadian J. Forest Res.* 6:6-12.
- FORCELLA, F. 1980. Cone predation by pinyon cone beetle (*Conophthorus edulis*): dependency on fre-

- quency and magnitude of cone production. Amer. Natur. 116:594-598.
- FRANKLIN, J. F., R. CARKIN, AND J. BOOTH. 1974. Seedling habits of upperslope tree species. I. A twelve-year record of cone production. Pacific Northwest Forest Range Exp. Sta. Res. Note PNW-213. 12 pp.
- HENSON, W. R. 1964. *Conophthorus coniperda* and the seed production of *Pinus strobus*. Pages 185-187 in Breeding pest resistant trees. Pergamon Press.
- MATTSON, W. E. 1971. Relationship between cone crop size and cone damage by insects in red pine seed production areas. Canadian Entomol. 103:617-621.
- . 1978. The role of insects in the dynamics of cone production of red pine. Oecologia 33:327-349.
- . 1980. Cone resources and the ecology of the red pine cone beetle, *Conophthorus resinosae* (Coleoptera: Scolytidae). Ann. Entomol. Soc. Amer. 73:390-396.
- MORGAN, F. D., AND M. MAILU. 1976. Behavior and generation dynamics of the white pine cone beetle *Conophthorus coniperda* (Schwarz) in central Wisconsin. Ann. Entomol. Soc. Amer. 69:863-871.
- PURITCH, G. S. 1972. Cone production in conifers. Pacific Forest Res. Center, Canadian Forest. Serv. Inform. Rep. BC-X-65. 94 pp.
- REHFELDT, G. E., A. R. STAGE, AND R. T. BINGHAM. 1971. Strobili development in western white pine: periodicity, prediction and association with weather. Forest Sci. 17:454-461.
- SCHENK, J. A., AND R. A. GOYER. 1967. Cone and seed insects of western white pine in northern Idaho. Distribution and seed losses in relation to stand density. J. Forest. 65:186-187.